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Simulation of the pharmaceutical service processes for an Oncological Healthcare Provider Institute (HPI) in Bogota

MBA Ever Ángel Fuentes[1], Daniela Ariza Chaverra[2], Natalia Andrea Sarmiento Esteban[3]

[1](*Industrial Engineering program, Engineering Faculty, Libre University, Colombia)*
[2](*Industrial Engineering program, Engineering Faculty, Libre University, Colombia)*
[3](*Industrial Engineering program, Engineering Faculty, Libre University, Colombia)*

ABSTRACT: *This research study is based on conducting a simulation in the pharmaceutical service of an oncology HPI in Bogota, in order to validate the times of each of the processes that integrate this area with the help of the Simio Simulation and Scheduling Software. The study begins with the diagnosis and collection of data, which were processed for analysis of the current behavior of the entity and its subsequent discrete modeling. From the information obtained there are lacks in the processes of storage, adequacy and distribution by their high occupancy rate, the proposals for improvement are aimed at reducing bottlenecks, idle times and improving efficiency in the system.*

KEYWORDS- *Pharmaceutical service, Processes, Simulation, Times*

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I. INTRODUCTION

Nowadays, it has been possible to appreciate the growing use of programs such as Flexsim, Vensim, Promodel, Simio, among others, which help the development of projects and research in the medical sector, some of them are of great importance as simulators, where all type of events can be represented to analyze and to extract information that offers a contribution of improvement and development in the organizations, mostly in health service systems, determine variables related to financial, capacity, optimization, allocation, customer care and procedures [1][2].

Several simulation projects have been carried out about the mentioned field, one of them studied the waiting queue that are produced in the pharmacy of the Hospital III José Cayetano Heredia of Piura in Peru where its development contributed in improvements of the process of attention of the pharmaceutical service and therefore the quality of this one to the client. These changes generate great benefits that contribute to the Good Will of the establishment by having an adequate, agile, flexible, appreciable, useful, timely, safe and reliable assistance generating potential clients and not only buyers [3]. The design of the simulation model generated statistics about waiting time, queue length and server utilization depending on the day the facility had more frequent patients and thus helped to provide better patient care. [4]

A study carried out in Cuba on queuing theory applied to the study of the service system of a pharmacy where it was determined and interpreted the variables and performance measures of the hospital pharmacy service system for the decision making in the short and medium term, in order to offer a bigger and better service and the customers' loyalty. Demonstrating through historical and statistical data, the adequate design of a service system using simulation within a pharmacy where it is evident that there is a high probability of constantly generating waiting queues. [5]

In another study conducted by a group of IFARMA researchers (2013), on the development of pharmaceutical services in Colombia, the importance of several entities in the operation of different processes in the area of pharmacy service was determined [6]; an investigation was initiated into 86 companies that manage these processes, in which it was identified that they have a very similar handling of medicines to administrative entities that provide services to this sector in the United States, due to its constant added value which also reduces the costs that are generated, there is evidence of an increase in medical service in all processes including the development of information systems. When comparing the functions of these entities in both Colombia and the United States, it can be found that there is coincidence in the nature of the association they have, but there is a difference in the policies for this sector in each country. [7]

In addition to this, there are projects related to queuing theories, known as a set of mathematical models, where waiting line systems can be described. Its main objective is to find the stable state of this and

determine an appropriate service capacity that guarantees a balance between the quantitative factor that would be the costs and the qualitative factor that has to do with the satisfaction of the client by the service. [8]

Oncology HPI in Bogota

It is a nonprofit institution, which has been operating for approximately 60 years, has high complexity pharmaceutical service, outpatient and chemotherapy unit, is an institution that has been growing gradually and has great recognition nationally and internationally.

The pharmaceutical service is the area with more processes of the entity, the responsibility of the service includes selection, acquisition, storage, distribution and dispensing of medicines to patients who come to HPI either to the outpatient pharmacy, or the chemotherapy unit; distribution is done nationally by sales to other HPI or to individual patients. In accordance with current regulations, the pharmaceutical service has an independent quality area that promotes continuous improvement, so it was decided to perform the simulation of processes that were updated in 2018 to validate the timing of each of its activities propose improvements.

Framework

There are several definitions about simulation, for Thomas. H Naylor "It is a numerical technique for conducting experiments on a digital computer. These tests comprise types of mathematical and logical relationships to describe the behavior and structure of complex real-world systems" [9][10], this tool is used for any case you want to model from the smallest and simplest to the most sophisticated. There are also other experts on the subject such as Robert E. Shannon who define simulation as "the process of designing and developing a computerized process of a system and conducting experiments with this model, for the purpose of understanding the behavior of the system or evaluating strategies with which the process can be operated". [11]

Another definition is from Arias Montoya, Margarita Portilla, & Fernández Henao who say that simulation is a technique for executing pilot studies, with fast results and at a relatively low cost, it is based on the modeling of sketches through simulation. For the model elaboration process, it involves a degree of abstraction that does not imply reality as such since it consists of a description that can be physical, verbal or abstract in form, along with the rules of operation. [12]

According to Taha there are two different types of simulation models:

• Continuous models deal with systems whose behavior changes continuously over time. For these models they usually use differential equations to describe interactions between different elements of the system.

• Discrete models are mainly concerned with the study of waiting lines with the aim of determining measures such as average waiting time and queue length. [13][14], which change only when a customer enters and leaves a system. The instants in which the changes occur in specific discrete points of time (Arrival and departure events), originate the name simulation event of this type [15]

For the development of this project, the discrete simulation is considered, which is a computer technique of dynamic system modeling. It is defined as "a program that reproduces the behavior of a real system following the pattern of events and interactions" [16][17][18]

II. METHODOLOGY

Initially, through the application of diagnostic tools it was possible to acquire and analyze information on the factors that affect each of the processes that make up the pharmaceutical service, designing with this data the respective characterization of the system.

Then the corresponding data collection is made to generate the simulation model based on a causal diagram which indicates the relationship that each of the elements of the system has so that in the modeling the times of each of the processes can be analyzed and validated.

System Characterization

The main objective of this entity characterization is to plan in a coordinated, controlled and timely manner the activities, procedures and interventions of a technical, scientific and administrative nature, related to pharmaceutical products used in health promotion, prevention, diagnosis, treatment and rehabilitation of the disease, in order to contribute harmoniously and comprehensively to the improvement of individual and collective quality of life.

The system begins with the selection process in which activities are developed for the application of new pharmaceutical products, review of their movement and verification of compliance through evaluations of suppliers, it should be noted that previously, this process had eight activities, which have been evaluated and modified due to the systematization that has been made, currently, there are four activities.

Following this, the information flow for the acquisition of pharmaceutical products begins, which is carried out through purchase confirmations, purchase orders to the supplier, entry of the pharmaceutical product

and follow-up of purchase orders. It is important to emphasize that previously, the acquisition process had five activities which have been evaluated and modified, seeking greater fluidity in the process, and with the updating of the technological tools of the pharmaceutical service, the reduction to four activities is achieved.

We continue with the technical reception, which is one of the most important processes in the chain because it is here that the technical conditions of the product are verified, such as physical, chemical and organoleptic properties, among others. For the entry, the administrative reception is carried out, which includes the verification of the product documentation, and in compliance with current regulations, the reception minutes are generated, the entry into the institutional software is carried out, the markers are generated for the identification of the products and they are stored in compliance with the technical requirements issued by the manufacturer, and inventory control and environmental conditions are carried out. This process has had a wide modification because it was totally manual and now it is systematized through the institutional software.

Subsequently, the dispensation is made which can be through the outpatient pharmacy to patients who claim their medications directly at the HPI; also it is made shipment at home by requirement of the patient, it is important to clarify that in all cases the patient must have medical prescription, otherwise it is not possible to deliver the medicine.

Appropriate drugs are also dispensed in unitary doses to the chemotherapy unit for administration to patients who have intravenous, intramuscular or subcutaneous chemotherapy protocols, this process has seven activities which are being evaluated and updated, due to remodeling and change of technology of the institution's mixing center. For now, the production and adaptation of medicines continues to be outsourced. Medicines administration is in charge of the nursing area.

Finally, the distribution process begins with an email where the client requests a quote for pharmaceutical products, either for private patients or institutions. In order to issue a quote, patient or institution information is verified, payments are confirmed, and invoicing is done, followed by the products being prepared and shipments made nationwide through a logistics operator specialized in medicines.

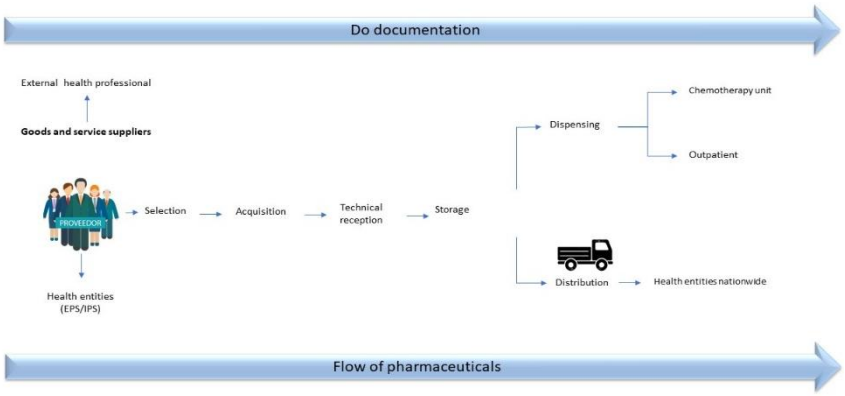

Figure 1. Supply chain of an HPI in Bogotá. Source: Authors, 2020.

From the information mentioned above, the supply chain is developed (Fig. 1) corresponding to the system to be simulated.

The supply chain is the systematic and strategic coordination of the traditional functions of an entity, with the purpose of improving long-term performance [19]. This diagram shows the organization of each of the processes that are in execution [20] that conform the pharmaceutical service of the HPI together with variables that influence this system such as products, documentation and suppliers in which diverse solutions can be found [21].

Time collection

Through interviews, the average time required for each of the activities that make up the processes of the pharmaceutical service was requested in order to analyze their behavior and validate them in the simulation model.

The number of applications, orders, quotations, pharmaceuticals products and patients that go through each of these processes were considered.

Causal diagram design

This is a diagram that shows the key elements of the process and the relationships between them. [22] It is a useful tool which allows to know the structure of a dynamic system. [23]

In System Dynamics, any aspect of the world is conceived as the causal interaction between attributes that describe it or also, it deals with how things change in time and how one can act without causing contradictory lateral effects [24].

Systemic representations are built with arrows and points, called causal diagrams, which capture all the hypotheses proposed by the modeler. [25]

Each causal link is assigned a polarity, either positive (+) or negative (-) to indicate how the dependent variable changes when the independent variable changes.

Positive polarity: when the independent variable changes, then the dependent variable changes in the same direction.

Negative polarity: when the independent variable changes, then the dependent changes in the opposite direction. [26]

This diagram is used to design the basis of a simulation, observing each of the variables involved in the system and their interactions [27] as shown in Fig. 2.

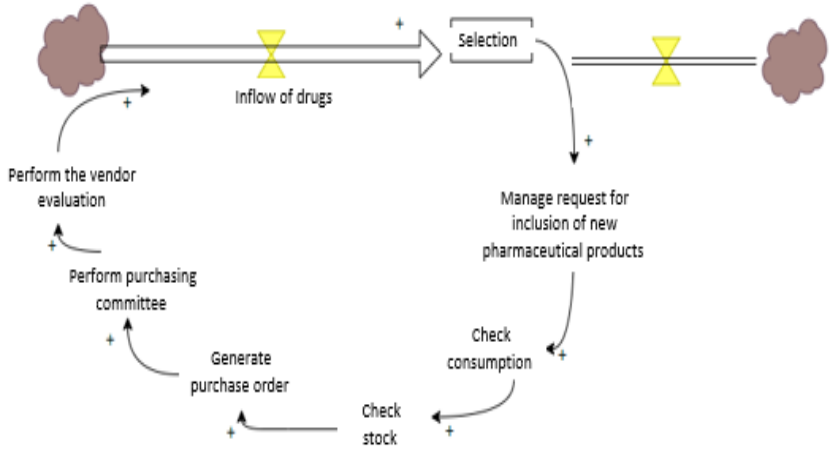

Figure 2. Causal diagram of the pharmaceutical service of an oncological HPI in Bogotá, Source: Authors, 2020.

For the design of this diagram it is required the use of a tool like Vensim which allows the construction of simulation models to see the dynamic behavior of the system being studied [28]

It is evident the formation of loops in each of the system process because they allow the feedback of information considering that each process is a phase that must follow a system order.

According to the activities evidenced in each process, it becomes clear that most of these positively affect the next one, the activities that negatively affect mainly refer to the storage part where the inventory is reduced each time there is a delivery of pharmaceutical products to patients.

Simulation model

Simulation is used to assist in decision making by providing a tool that allows the current behavior of a system to be analyzed and understood. It can also help predict the performance of that system under several scenarios determined by the decision maker. [29]

It is a logical-mathematical model of a system from which an imitation of the operation of a real process through time is obtained [30].

A program that reproduces the behavior of a real system following the most known pattern of interactions will be used as a discrete simulation [31][32].

The software used to develop the simulation was SIMIO; it is characterized by being a predictive tool because it can be used to model discrete processes, it has a mixed approach where objects and procedures are combined, focused on the creation of logistic and industrial behavior models [33]

The simulation model is made for the time validation of the pharmaceutical service processes of the oncology HPI in Bogotá (Fig. 3) keeping in mind:

- Activities of each one of the processes
- Personnel involved in each process
- Processing time for each activity
- Patients and orders being processed

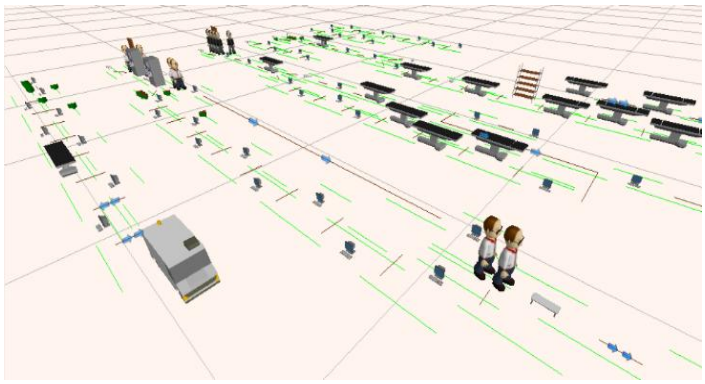

Figure 3. Simulation of the pharmaceutical service of an oncological HPI in Bogota. Source: Authors, 2020.

The simulation is carried out bearing in mind a previous time of 48 hours to be able to start with elements in process inside the system and together with 100 replicas to obtain a better average of each of the data to be analyzed.

Reference codes are assigned to each of the activities, designated in table 1, in order to understand each part of the simulation.

Table 1. Activity codes that make up the processes of the pharmaceutical service of an oncological HPI in Bogotá

ACTIVITY	CODE	ACTIVITY	CODE
MANAGE REQUEST FOR INCLUSION OF NEW PHARMACEUTICAL PRODUCTS	S1	VALIDATE THE MEDICAL PRESCRIPTION	DUO1
CHECK CONSUMPTION	S2	CHECK AVAILABILITY OF PHARMACEUTICAL PRODUCTS	DUO2
CHECK STOCK	S3	ENLIST PHARMACEUTICAL PRODUCTS FROM PRE-APPLICATION	DUO3
GENERATE PURCHASE ORDER	S4	DELIVER PHARMACEUTICAL PRODUCTS TO NURSING	DUO4
PERFORM PURCHASING COMMITTEE	S5	GENERATE PRODUCTION ORDER	DUO5
PERFORM THE VENDOR EVALUATION	S6	REQUEST PHARMACEUTICAL PRODUCTS FOR ADEQUACY	DUO6
		ENLIST PRODUCTS FOR ONCOLOGY ADEQUACY	DUO7
CONFIRM AND SUBMIT PURCHASE ORDER	ADQ1	VERIFY THE READINESS OF PRODUCTS FOR ONCOLOGICAL ADEQUACY	DUO8
SEND PURCHASE ORDER TO SUPPLIER	ADQ2	CONFIRM PATIENTS	DUO9
ENTER PHARMACEUTICAL PRODUCTS	ADQ3	PREPARE ONCOLOGICAL MIXTURES	DUO10
FOLLOW UP ON PURCHASE ORDERS	ADQ4	DISPENSE ONCOLOGY MIXTURES	DUO11
		INVOICE PHARMACEUTICAL PRODUCTS	DUO12
VERIFY DOCUMENTATION	RT1	RETURN OF PHARMACEUTICALS PRODUCTS	DUO13
TECHNICAL VERIFICATION OF PHARMACEUTICALS PRODUCTS	RT2	ARCHIVE MEDIA IN THE BATCH RECORD	DUO14
PREPARE DELIVERY/RECEPTION REPORT	RT3		
ENTER PHARMACEUTICAL PRODUCTS INTO THE INSTITUTIONAL SOFTWARE	RT4	REQUEST AN APPOINTMENT	DPA1
PERFORM DOCUMENT MANAGEMENT	RT5	MIPRES PROGRAMMING	DPA2
IDENTIFY PHARMACEUTICALS PRODUCTS	RT6	ATTEND PATIENT FOR BILLING	DPA3
CARRY OUT STORAGE OF PHARMACEUTICAL PRODUCTS	RT7	ENTER THE USER IN THE INSTITUTIONAL SOFTWARE	DPA4
		CHECK DRUG AVAILABILITY	DPA5
REVIEW THE INSTITUTIONAL IDENTIFICATION OF PHARMACEUTICAL PRODUCTS	AL1	LIST PHARMACEUTICALS PRODUCTS	DPA6
STORE PHARMACEUTICALS PRODUCTS	AL2	INVOICING PHARMACEUTICALS	DPA7
CARRY OUT CONTROL OF COOLING AND FREEZING AMBIENT CONDITIONS	AL3	COMPLETE REGISTRATION OF PENDING PHARMACEUTICALS PRODUCTS	DPA8
PERFORM BATCH CONTROL AND EXPIRATION DATES	AL4	IDENTIFY PROCESS DEVIATIONS	DPA9
PERFORM INVENTORY CONTROL	AL5	PERFORM PATIENT VERIFICATION	DPA10
RUPTURES AND BREAKDOWNS	AL6	PERFORM CASH CLOSING	DPA11
FINAL DISPOSAL OF PHARMACEUTICAL PRODUCTS	AL7	PERFORM THE MIPRES REGISTRATION	DPA12
PERFORM CLEANING AND DISINFECTION OF THE WAREHOUSE AREAS	AL8	CHECK BILLING	DPA13

		MAKE BILLING DELIVERY TO THE BILLING AREA	DPA14
CARRY OUT THE PRODUCTION ORDER AND SEND IT TO AN OUTSOURCED MIXING PLANT	ADE1		
CONFIRM PATIENTS WHO WILL BE ATTENDING MEDICINE ADMINISTRATION AND DELIVERY TO THE CHEMOTHERAPY UNIT	ADE2	RECEIVE REQUEST BY MAIL	DIS1
MAKE PRE-ORDER AND ORDER OF PHARMACEUTICAL PRODUCTS	ADE3	ISSUE A QUOTE	DIS2
PERFORM TECHNICAL RECEPTION OF ONCOLOGICAL MIXTURES	ADE4	RECEIVE CONSIGNMENT	DIS3
REGISTER QUALITY CONTROL	ADE5	VERIFY CUSTOMER INFORMATION FOR DELIVERY	DIS4
PERFORM PHARMACEUTICAL PRODUCT USAGE REPORT	ADE6	PERFORM BILLING	DIS5
ARCHIVE SUPPORTS IN BATCHRECORD	ADE7	LIST OF PHARMACEUTICALS PRODUCTS	DIS6
		REVIEW PHARMACEUTICAL PRODUCT LISTING	DIS7
		SEND THE ORDER	DIS8

Source: Authors, 2020.

III. RESULTS

An analysis is made of the percentage of monthly use of each of the activities of the individual and general processes that make up the pharmaceutical service.

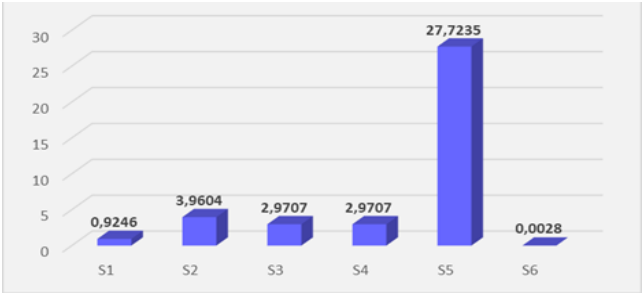

Figure 4. Percentage of use of each activity in the selection process. Source: Authors, 2020.

In the selection process (Fig. 4) the activities to manage the request for inclusion of new products and perform the evaluation of the supplier have a percentage of use not exceeding 1% and the activities to review consumption, review stocks and generate purchase orders have a percentage of use not exceeding 4% with this it follows that these do not require much time to be performed.

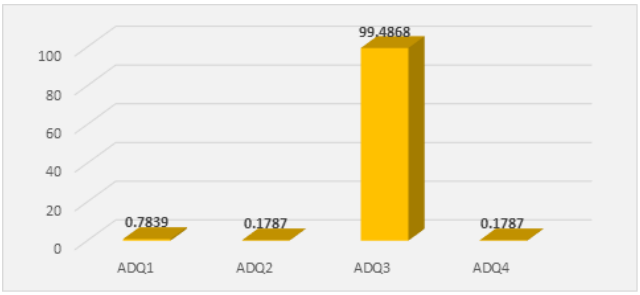

Figure 5. Percentage of use of each activity in the acquisition process. Source: Authors, 2020.

In the acquisition process (Fig. 5), the activities of confirming and sending purchase order confirmation, purchase order to the supplier and follow-up to purchase orders have a percentage of use between 0% and 1% due to the fact that they do not require much time to be carried out. The activity of entering pharmaceutical products has a high percentage of use (99.46%) since it is carried out after the technical reception process and processes a high level of orders.

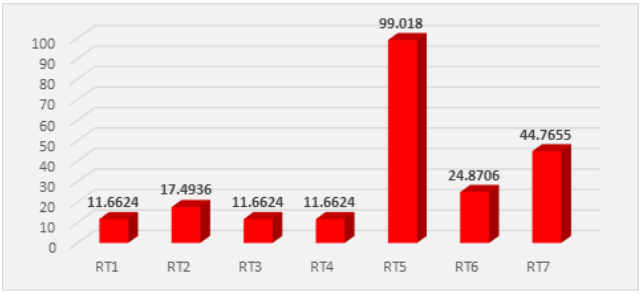

Figure 6. Percentage of use of each activity in the technical reception process. Source: Authors, 2020.

In the technical reception process (Fig. 6), it is evident that the activities of document verification, technical verification of the product, and elaboration of delivery/entry records of products into the software have a similar percentage, ranging from 11% to 18%, due to the fact that the document part of this process is carried out there, there is also evidence of much higher utilization percentages due to the fact that verification and identification activities are carried out for each of the products received for their subsequent storage. This takes up a greater amount of time.

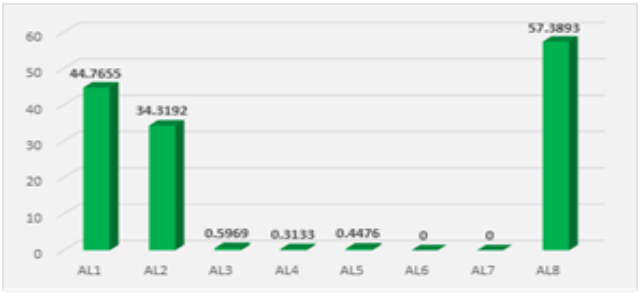

Figure 7. Percentage of utilization of each activity in the storage process. Source: Authors, 2020.

In the storage process (Fig. 7), it is evident that the activities of control of environmental conditions and refrigeration, control of lots and expiration dates and inventory control have a percentage of use between 0% and 1%. There is a great flow of products in this process, it is executed by five pharmacy assistants which generates its efficiency. The activities of ruptures and breakdowns and final disposal of the product do not have any time to be carried out because there have been no eventualities in the last year. On the other hand, the activity of cleaning and disinfection of areas has a percentage of use of 57.38% be-cause the person of general services uses half a day to do it.

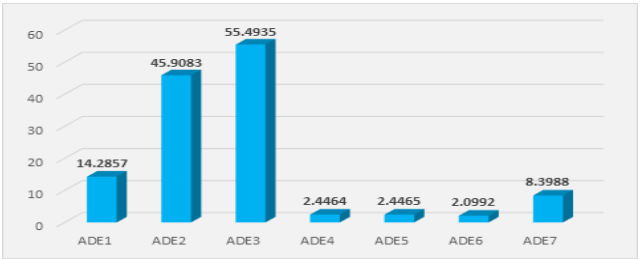

Figure 8. Percentage of use of each activity in the adaptation process. Source: Authors, 2020.

In the adaptation process (Fig. 8), it is evident that activities such as placing the production order and sending the mixtures to the central, confirming patients who will attend the administration of the medicine and the delivery of medicines to the chemotherapy unit, have a higher percentage of use due to the fact that they depend on the outsourced mixing plant, which causes a little more time. The activities of reception of oncological mixtures, quality control, product use report and support to the batch record do not require much time to be carried out because they are more documentary activities.

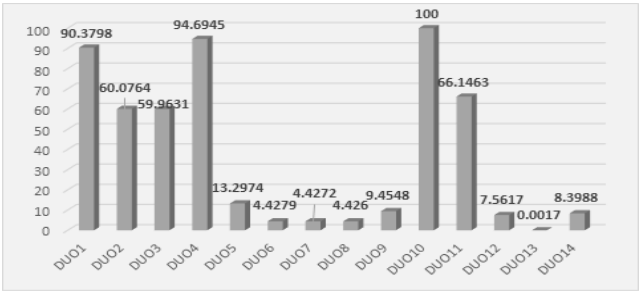

Figure 9. Percentage of utilization of each activity in the internal dispensing process. Source: Authors, 2020.

In the process of internal dispensing or oncology unit (Fig. 9), it is evident that the activities Request pharmaceutical products for adaptation, list products for adaptation of oncology, verify the preparation of products for adaptation of oncology, have percentages of use between 4% and 5% because they are per-formed simultaneously, the activity of preparing oncological mixtures has a 100% utilization percentage because it requires a lot of time to be carried out. This process is carried out externally with a supplier (outsourced mixing center) and the remaining activities have a low utilization percentage because they are more documentary and do not require much time to be carried out.

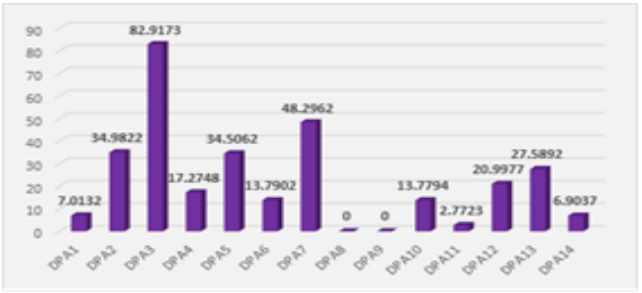

Figure 10. Percentage of utilization of each activity in the external dispensing process. Source: Authors, 2020.

In the external dispensing or outpatient process (Fig. 10) it is evident that the activities of making appointments, scheduling MiPres, attending patients for billing, entering the user in the institutional software, verifying drug availability, preparing pharmaceutical products, and billing pharmaceutical products have a high percentage of use due to the care they must provide to patients, The activities of completing the registration of pharmaceutical products and identifying deviations from the process have a low percentage of use because there are no pending products or deviations in the process and the remaining activities have a percentage of use that ranges between 2% and 28% because they are developed in relation to the documentary part and do not require much time to be performed.

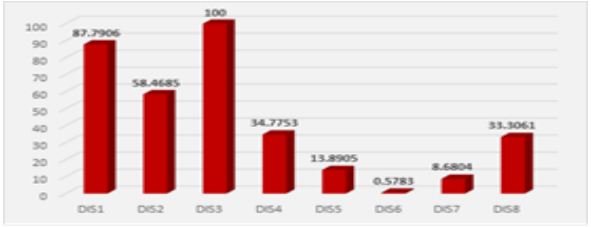

Figure 11. Percentage of use of each activity in the distribution process. Source: Authors, 2020.

In the distribution process (Fig. 11), it is evident that most activities have a percentage that exceeds 30% of utilization be-cause a variety of mail is received and needs to be processed, activity 3, completes 100% of utilization because the consignments need a lot of time to be processed and the activities that do not exceed 20% are due to the fact that they are part of the documentation and do not require much time to be carried out.

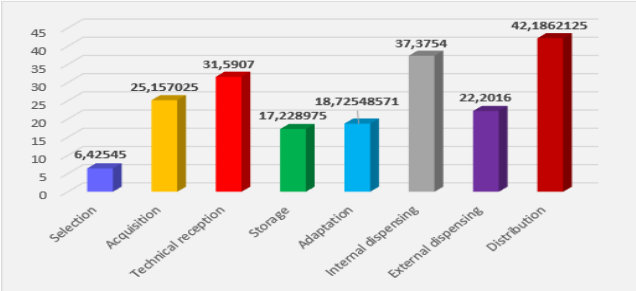

Figure 12. Percentage of use of each process of the pharmaceutical service in an oncological HPI in Bogotá. Source: Authors, 2020.

In Fig. 12, the percentage of use promised for each of the processes that make up the pharmaceutical service of an onco-logical HPI in Bogotá is represented, where it is evident that the process with the lowest percentage is the selection one because it does not require much time from the workday to complete its activities, while the majority of processes have percentages of use that ranging between 18% and 43% because they require active processing of orders, patients and/or products.

The data obtained in the simulation show that they effectively correspond to the average time that was collected in interviews with the entity, demonstrating the correct validation of these, represented in Table 2.

Table 2. Time validation of pharmaceutical service processes

PROCESSES	USAGE PERCENTAGE (MONTHLY)	
	SIMULATION	REAL
Selection	6,4255	4,9476
Acquisition	25,1570	21,5632
Technical reception	31,5907	25,8763
Storage	17,2290	17,9781
Adequacy	18,7255	21,1587
Internal Dispensing	37,3754	25,1498
External Dispensing	22,2016	18,0623
Distribution	42,1862	144,0168

Source: Authors, 2020.

It is possible to observe the comparison of the usage percentage extracted from the simulation model and the real process developed by the pharmaceutical service area of the oncological HPI in Bogotá. For this, the amount of time required by each of the processes during a monthly period was considered. This table validates the times of the processes that the entity con-templates showing a similar development in each one, those that in the real process surpass the percentage of the modeling re-quire improvements to diminish their time of occupation and to be more efficient.

The averages that present a high percentage and processing time are since they are processes that are carried out simultaneously with other workers or external suppliers and make the times extend. Therefore, it is concluded that the processes need an improvement proposal in order to maintain or reach their efficiency.

Improvement proposal

Based on the usage percentage presented, the following improvement proposals related to each process are suggested:

• For the distribution process, it is proposed to expand the payment options of the drugs through platforms such as nequi, daviplata, movii, PayPal among others that can be managed virtually because the activity that makes this process extensive is the consignment. By providing the patient with several options that accommodate the virtuality that is handled today can make this process more efficient and expedite the delivery of requirements. In addition to suggesting the maintenance of home drug delivery service which has been beneficial for both the entity and users

• For the internal dispensing process, the implementation of the mixing plant is approved in the entity that is currently under development because it reduces costs with suppliers, transfer times and applications

• For the storage process it is proposed to know the areas of enlistment and dispatch in order to avoid the pharmaceutical products alteration at the time of making the storage or its respective distribution

• For the technical reception process, it is proposed to assign a pharmacy assistant who is in the storage process to carry out the process of transferring the products to the warehouse as soon as the technical reception regent carries out the incoming activities (when there is a high flow of incoming pharmaceutical products) because if the merchandise is collected as soon as they arrive, confusion with other suppliers is avoided

• For the external dispensing process, a percentage of acceptable use is presented, it is suggested to keep the pace of activities and it is also proposed the implementation of an application or a space on the website that allows users to make an appointment to request and collect the medicines to avoid waiting lines at the entity

• For the selection and acquisition processes that handle several activities in a documentary way, it is suggested to maintain the time of realization because they do not present significant delays in their development

Additionally, proposals are suggested at a general level that may be beneficial to the area.

It is proposed to carry out an effective method of internal communication with which it allows to know the activities of each regent, with the purpose of mitigating the possibility of making mistakes. In addition to continuing with the use of coded for-mats, to perform compliance checks of the software that the entity has implemented for the general development of the pharmaceutical service.

Planning: this person must have knowledge of the different activities so that he/she can direct and control all the processes.

Training: for this phase, it is intended to generate motivation and interest on the part of all employees, in such a way that they become aware of the importance and of the changes that can occur at a general level in society.

Finally, a matrix of indicators is proposed, which will allow the process to carry traceability on the management of each activity that composes the area of the pharmaceutical service, considering the indicators that the process already have.

Performance indicators matrix for the review of pharmaceutical service processes is a tool that makes easy the concise planning considering the proposed objectives of a process or program, where it incorporates, obtains and verifies the information from the indicators according to their performance.

Graphically, it is a table that arranges elements in rows and columns. In this case, the rows present information on the processes, indicators, validation rules, periodicity, average and status, while the columns represent the information on the activities that are subject to the indicators.

Therefore, in general, a matrix of indicators is proposed, which allows the pharmaceutical service to demonstrate the traceability and efficiency of the management of each activity of the processes that make up the area, taking into account the indicators established within the characterization which measure results obtained during the development of a process allowing decision making [34][35]

It is clarified that the matrix will be filled out by the person in charge, considering the indicators of each area and its measurement scale, in a correct way in each item to avoid reprocessing.

IV. DISCUSSION OF THE SIMULATION MODEL

Simulation is a useful tool to represent different scenarios as medical centers and health area, there are some related articles as:

The application of discreet simulation in the emergency area of a service provider to reduce patient loss.

The analysis of patient flow in the emergency department of the Samaritan University Hospital through discrete simulation.

The first focuses on the emergency department, where different elements are modeled to achieve an increase in financial income and a reduction in patient transfers to other entities [36]. The second article mainly analyzes the flow of patients in terms of their care, stay and use of available resources [37][38]. Both of them develop a simulation of a discrete type and evaluate queuing problems to generate different scenarios that achieve evidence of a reduction of time in the system and the financial area.

In general, it can be seen that the articles mentioned and the present have in common the type of simulation so that, discrete type data is used due to the variability of the data, in this case a modeling is made to validate the times of the processes of the pharmaceutical service of the IPS in Bogotá and likewise, to evaluate the present situation of the area to offer proposals that generate a greater operativity in an efficient way without gener-ating additional costs in the entity.

The mentioned articles demonstrate the time reduction that the simulation can generate, but they do not mention in detail proposals for the improvement of the performance of the entity being studied.

This project offers different proposals that are evaluated to show the impact they will generate in each of the entity's processes

Table 3 shows a matrix containing each of the proposals detailed above and the processes of the pharmaceutical service area of the HPI in Bogotá, which are related to each other by means of a score depending on the impact of improvement (1, low impact; 2, medium impact; 3, high impact).

Table 3. Impact evaluation matrix of the pharmaceutical service processes of the HPI in Bogota

HPI in Bogotá									
PROCESSES / IMPROVEMENT PROPOSAL	Selection	Acquisition	Technical reception	Storage	Adequacy	Internal dispensing	External dispensing	Distribution	**Total**
Follow-up on completion	3	3	3	3	3	3	3	3	**24**
Distribution of dispatch areas	1	1	2	3	1	2	2	3	**14**
Work plan	3	3	3	3	3	3	3	3	**24**
Planning	3	3	3	3	3	3	3	3	**24**
Training	3	3	3	3	3	3	3	3	**24**
Traceability	3	3	3	3	3	3	3	3	**24**
Extend payment methods	1	1	1	1	1	3	3	3	**14**
Mixing station	1	1	1	2	3	3	1	1	**13**
Staff distribution	1	1	3	3	1	1	1	1	**12**
Stability	3	3	3	3	2	2	2	2	**20**
Platform to request medicines	2	2	2	3	3	3	3	3	**21**
Deliveries	1	1	1	1	1	2	3	3	**13**
Total	**25**	**25**	**28**	**31**	**27**	**31**	**30**	**31**	

Source: Authors, 2020.

It follows that the proposals for monitoring compliance with the work plan, planning, training and traceability are illustrated in a general manner for the entire area of pharmaceutical service, positively impacting a value of 24 points in each for all processes, while the others do so in the manner detailed above benefiting a specific process.

The percentages of impact that the improvement proposals have on the processes of the pharmaceutical service area range from 54% to 100%. The lower percentages impact a specific process and those that have 100% contribute to the whole operation of the pharmaceutical service of the entity.

The processes that make up the pharmaceutical service area of the entity have a good final score highlighting mainly the processes: storage, dispensing of oncological unit and distribution with a total of 31 points each, this can corroborate that the proposals for improvement established meet the need to reduce bottlenecks that resulted in the simulation made.

V. CONCLUSIONS

Simulation is a fairly comprehensive tool that can be used for various areas where you can analyze process times, bottlenecks, process efficiency, among many other variables. For the development of this project, it manages to validate the times of each phase that conforms the pharmaceutical service demonstrating that at the moment they present a certain percentage of occupation in which selection and acquisition are those that are made of more efficient way in relation to the others.

It is viable to implement improvement tools and/or industrial engineering methodologies for the Bogotá oncological HPI in the pharmaceutical service. The improvement proposal presented will help generate adequate conditions in the area to achieve significant changes in the activities of each process.

The indicator matrix allows the collection of data that helps to increase the traceability of processes, decrease human errors associated with the handling of medicines and medical supplies, greatly increase the speed of response to services and have greater control over the products in the inventory.

The use and establishment of performance indicators can generate a greater use, efficiency and cost reduction in each of the processes of the pharmaceutical service of the entity, evidencing the possibility of acquiring new software for better management and security of the inventory at the time of rotation and dispensing of pharmaceuticals

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